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(71) Applicant: **NISSAN MOTOR CO LTD**

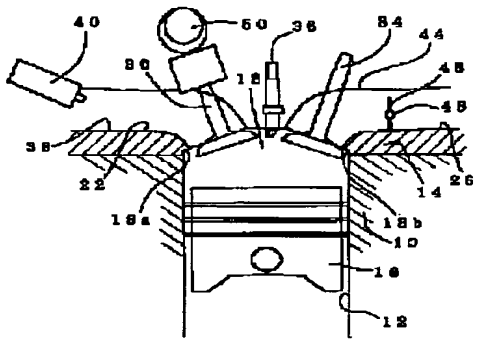
(72) Inventor: **IIYAMA AKIHIRO**
URUSHIBARA TOMONORI

(54) **SPARK IGNITION INTERNAL COMBUSTION ENGINE**

(57) Abstract:

PROBLEM TO BE SOLVED: To provide a spark ignition internal combustion engine capable of performing good combustion in both self ignition combustion and spark ignition combustion, also easily ensuring durability of the engine and a seal property of combustion gas.

SOLUTION: An internal combustion engine is provided with a first/second intake valves 30 and a first/second exhaust valves 34, respectively opening/ closing a first/second intake passages 22 and a first/second exhaust passages 26 opened to a combustion chamber 18 synchronously with rotation of the engine, and a control valve 46 changing actual compression ratio of the engine by changing open/close timing of both the intake valves 30. In this constitution, the actual compression ratio at self ignition combustion time and the actual compression ratio at spark ignition operation time are made different by this control valve 46.



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(71)出願人　000003997
日産自動車株式会社
神奈川県横浜市神奈川区宝町２番地

(72)発明者　飯山　明裕
神奈川県横浜市神奈川区宝町２番地　日産自動車株式会社内

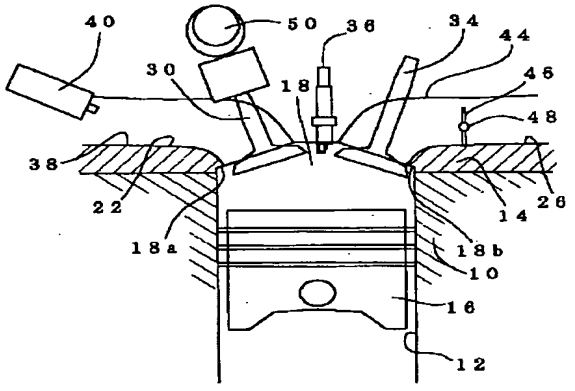
(72)発明者　漆原　友則
神奈川県横浜市神奈川区宝町２番地　日産自動車株式会社内

(54)【発明の名称】　火花点火式内燃機関

(57)【要約】

【課題】　自己着火燃焼と火花点火燃焼の両方の燃焼と良好に行わせることができるとともに、機関の耐久性や燃焼ガスのシール性を容易に確保することができる火花点火式内燃機関を提供すること。

【解決手段】　機関の回転に同期して燃焼室１８に開口する第１吸気通路２０，第２吸気通路２２および第１排気通路２４，第２排気通路２６をそれぞれ開閉する第１吸気弁２８，第２吸気弁３０および第１排気弁３２，第２排気弁３４と、両吸気弁２８，３０の開閉時期を変更することにより機関の実圧縮比を変更する制御弁４６とを備え、この制御弁４６により、自己着火燃焼時の実圧縮比と火花点火運転時の実圧縮比とを異ならせる構成とした。



【特許請求の範囲】

【請求項１】　所定の運転領域で自己着火燃焼を行わせ、前記所定の運転領域以外の運転領域で火花点火燃焼を行わせる火花点火式内燃機関において、
機関の回転に同期して燃焼室に開口する吸気通路および排気通路をそれぞれ開閉する吸気弁および排気弁と、前記吸気弁の開閉時期を変更することにより機関の実圧縮比を変更する可変動弁機構と、を備え、
この可変動弁機構により、自己着火燃焼時の実圧縮比と火花点火運転時の実圧縮比とを異ならせることを特徴とする火花点火式内燃機関。

【請求項２】　自己着火燃焼時の実圧縮比を火花点火運転時の実圧縮比よりも高くすることを特徴とする請求項１記載の火花点火式内燃機関。

【請求項３】　シリンダ略中央に配設された火花点火プラグと、
燃焼室に開口する吸気通路および排気通路と、
機関の回転に同期して前記吸気通路と排気通路とをそれぞれ開閉する吸気弁および排気弁と、
前記吸気弁の開閉時期を変更することにより機関の実圧縮比を変更する可変動弁機構と、
既燃ガスの一部を燃焼室内に残留させる既燃ガス残留手段と、を備え、
所定の運転領域では、前記既燃ガス残留手段により既燃ガスの一部を燃焼室内に残留させるとともに前記可変動弁機構により機関の実圧縮比を高めることで自己着火燃焼を行わせ、前記所定の運転領域以外の運転領域では、前記既燃ガス残留手段による既燃ガスの残留を減少させるとともに前記可変動弁機構により機関の実圧縮比を低下させて前記火花点火プラグによる火花点火燃焼を行わせることを特徴とする火花点火式内燃機関。

【請求項４】　前記既燃ガス残留手段は、前記排気弁の閉じ時期を早めることにより既燃ガスの一部を燃焼室内に残留させる第２の可変動弁機構であることを特徴とする請求項３記載の火花点火式内燃機関。

【請求項５】　前記既燃ガス残留手段は、前記排気通路とは独立に設けられた第２の排気通路と、機関の排気行程と吸気行程とで前記第２の排気通路を開く第２の排気弁と、機関の回転に関わらず前記第２の排気通路を開閉可能な開閉手段と、からなり、前記開閉手段を開くことにより排気行程中に前記第２の排気通路に排出された既燃ガスを吸気行程中に燃焼室内に導入して既燃ガスの一部を燃焼室内に残留させることを特徴とする請求項３記載の火花点火式内燃機関。

【請求項６】　前記燃焼室は、前記吸気通路が開口する側と前記排気通路が開口する側とが略対称形に形成されることを特徴とする請求項５記載の火花点火式内燃機関。

【請求項７】　前記可変動弁機構は、前記吸気弁を駆動する吸気カムシャフトと機関のクランクシャフトとの位相を変更することにより、前記所定の運転領域では前記吸気弁のバルブタイミングを進角させて機関の実圧縮比を高め、前記所定の運転領域以外の運転領域では前記吸気弁のバルブタイミングを遅角させて機関の実圧縮比を低下させることを特徴とする請求項５または６記載の火花点火式内燃機関。

【請求項８】　前記所定の運転領域とそれ以外の運転領域との間で機関の運転条件が変化したときに、前記既燃ガス残留手段の作動時期と前記可変動弁の作動時期とを異ならせることを特徴とする請求項３から７のいずれかに記載の火花点火式内燃機関。

【請求項９】　前記所定の運転領域以外の運転領域から前記所定の運転領域へ機関の運転条件が変化したときには前記吸気弁のバルブタイミングを進角させた後に前記開閉手段を開き、前記所定の運転領域からそれ以外の運転領域へ機関の運転条件が変化したときには前記開閉手段を閉じた後に前記吸気弁のバルブタイミングを遅角させるよう前記可変動弁機構と前記開閉手段とを制御することを特徴とする請求項７記載の火花点火式内燃機関。

【請求項１０】　前記所定の運転領域は部分負荷領域に設定されることを特徴とする請求項１から９のいずれかに記載の火花点火式内燃機関。

【請求項１１】　前記所定の運転領域の周囲にヒステリシス領域を設定することを特徴とする請求項１から１０のいずれかに記載の火花点火式内燃機関。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、運転領域に応じて自己着火燃焼と火花点火燃焼との両方を行わせる火花点火式内燃機関の改良に関する。

【０００２】

【従来の技術】２サイクル型の内燃機関の分野においては、低負荷運転領域で自己着火燃焼を行わせる機関について様々な提案がなされており、例えば、特開平９－２４２５７０号公報には、自己着火燃焼に適した圧縮比と通常の火花点火燃焼に適した圧縮比との両立を図るため、運転状態に応じて燃焼室容積を変更するものが開示されている。

【０００３】

【発明が解決しようとする課題】本出願人はこの様な自己着火を４サイクル型の内燃機関に適用する場合に特に有効な技術を先に提案している（特願平９－２９６５６７号等）。４サイクル型の内燃機関においても自己着火燃焼と火花点火燃焼との両方を良好に行わせるにはそれぞれに適した圧縮比とするのが望ましいのであるが、前述の従来技術のように燃焼圧力を直接受ける部位に可動部材を設けて圧縮比を可変にする場合は、可動部分の耐久性確保や可動部分の燃焼ガスのシール性確保等が困難となる。

【０００４】ところで、一般的な４サイクル型の内燃機

関のように、燃焼室内への新気あるいは燃料との混合気の充填効率が機関の回転に同期して駆動される吸気弁の開閉時期によって変化する機関では、吸気弁の開閉時期を変更することにより実質的な圧縮比を変更することが可能である。本発明は、機関の回転に同期して駆動される吸気弁を有する内燃機関を前提とし、自己着火燃焼と火花点火燃焼との両方の燃焼とも良好に行わせる火花点火式内燃機関を提供することを目的とする。

【０００５】

【課題を解決するための手段】そこで、請求項１の発明は、所定の運転領域で自己着火燃焼を行わせ、前記所定の運転領域以外の運転領域で火花点火燃焼を行わせる火花点火式内燃機関において、機関の回転に同期して燃焼室に開口する吸気通路および排気通路をそれぞれ開閉する吸気弁および排気弁と、前記吸気弁の開閉時期を変更することにより機関の実圧縮比を変更する可変動弁機構と、を備え、この可変動弁機構により、自己着火燃焼時の実圧縮比と火花点火運転時の実圧縮比とを異ならせることを特徴としている。

【０００６】具体的には、例えば請求項２記載の発明のように、自己着火燃焼時の実圧縮比を火花点火運転時の実圧縮比よりも高くする。この場合、機関のボア径やピストンのストローク、燃焼室の容積等は不変であり、燃焼室回りの構造を複雑にする必要がないので、機関の耐久性や燃焼ガスのシール性を容易に確保することができる。また、実圧縮比がそれぞれの燃焼状態に適するように変更されるため、自己着火燃焼を行わせるときの圧縮行程では、高い実圧縮比によって燃焼室内のガスが良好に昇温され、火花点火燃焼を行わせるときには自己着火燃焼時よりも低い実圧縮比によってノッキングの発生が良好に抑制される。

【０００７】詳しくは、請求項３記載の発明のように、シリンダ略中央に配設された火花点火プラグと、燃焼室に開口する吸気通路および排気通路と、機関の回転に同期して前記吸気通路と排気通路とをそれぞれ開閉する吸気弁および排気弁と、前記吸気弁の開閉時期を変更することにより機関の実圧縮比を変更する可変動弁機構と、既燃ガスの一部を燃焼室内に残留させる既燃ガス残留手段と、を備え、所定の運転領域では、前記既燃ガス残留手段により既燃ガスの一部を燃焼室内に残留させるとともに前記可変動弁機構により機関の実圧縮比を高めることで自己着火燃焼を行わせ、前記所定の運転領域以外の運転領域では、前記既燃ガス残留手段による既燃ガスの残留を減少させるとともに前記可変動弁機構により機関の実圧縮比を低下させて前記火花点火プラグによる火花点火燃焼を行わせるようにすることができる。自己着火燃焼を行わせるときには、燃焼室内に残留した既燃ガスが前述の高い圧縮比によって圧縮行程で良好に昇温され、これが火種となって安定した自己着火燃焼が実現される。

【０００８】既燃ガスを燃焼室内に残留させるには、請求項４記載の発明のように、第２の可変動弁機構によって排気弁の閉じ時期を早めることにより実現される。あるいは、請求項５記載の発明のように、前記既燃ガス残留手段を、前記排気通路とは独立に設けられた第２の排気通路と、機関の排気行程と吸気行程とで前記第２の排気通路を開く第２の排気弁と、機関の回転に関わらず前記第２の排気通路を開閉可能な開閉手段と、から構成し、前記開閉手段を開くことにより排気行程中に前記第２の排気通路に排出された既燃ガスを吸気行程中に燃焼室内に導入して既燃ガスの一部を燃焼室内に残留させるようにすることができる。この場合、吸気通路から燃焼室内に導入された新気（混合気）と第２の排気通路から燃焼室内に導入された既燃ガスとが燃焼室内で偏在するようになり、排気側から吸気側への自己着火が行われる。ここで燃焼室は、請求項６記載の発明のように、前記吸気通路が開口する側と前記排気通路が開口する側とが略対称形に形成された、いわゆるクロスフロー形式とすると良い。これにより、新気（混合気）と既燃ガスとが燃焼室内で成層化され、その境界面において、さらに良好に自己着火が行われる。

【０００９】また、可変動弁機構は、請求項７記載の発明のように、前記吸気弁を駆動する吸気カムシャフトと機関のクランクシャフトとの位相を変更することにより、前記所定の運転領域では前記吸気弁のバルブタイミングを進角させて機関の実圧縮比を高め、前記所定の運転領域以外の運転領域では前記吸気弁のバルブタイミングを遅角させて機関の実圧縮比を低下させることができる。

【００１０】請求項８記載の発明では、前記所定の運転領域とそれ以外の運転領域との間で機関の運転条件が変化したときに、前記既燃ガス残留手段の作動時期と前記可変動弁の作動時期とを異ならせるようにしている。既燃ガスの残留量と圧縮比とはともに機関の燃焼に大きな影響があり、これらの変更は適切なタイミングで行う必要がある。通常、既燃ガス残留手段や可変動弁機構は瞬時に切換えるようなものではなく、ある速度でもって作動し、またこの速度が機関の状態で変化する場合もある。自己着火燃焼と火花点火燃焼とを切換えるときにこのような２つの手段を同時に作動させると、切換開始から完了までの間に予想し得ない既燃ガス残留量と圧縮比の状態を通過することになるが、両者の作動時期を異ならせることでこのような問題を生じることなく、円滑に２つの燃焼状態を切換えることができる。

【００１１】また、既燃ガス残留手段の作動部が開閉手段であり、可変動弁機構が吸気カムシャフトと機関のクランクシャフトとの位相を変更する機構である場合には、請求項９記載の発明のように、前記所定の運転領域以外の運転領域から前記所定の運転領域へ機関の運転条件が変化したときには前記吸気弁のバルブタイミングを

進角させた後に前記開閉手段を開き、前記所定の運転領域からそれ以外の運転領域へ機関の運転条件が変化したときには前記開閉手段を閉じた後に前記吸気弁のバルブタイミングを遅角させるよう前記可変動弁機構と前記開閉手段とを制御すると良い。なお、自己着火燃焼を行わせる所定の運転領域は、請求項１０記載の発明のように、部分負荷領域に設定することができる。また、請求項１１記載の発明のように、所定の運転領域の周囲にヒステリシス領域を設定すると２つの燃焼状態の頻繁な切換が抑制され、機関をより円滑に運転することができる。

【００１２】

【発明の実施の形態】次に、本発明を火花点火式内燃機関である４サイクル型の自動車用ガソリンエンジンに適用した実施の形態を、添付図面に基づいて詳細に説明する。図１、２に示すように、シリンダブロック１０には、複数のシリンダ１２が直列に配置されており、その上面を覆うように、シリンダヘッド１４が固定されている。シリンダ１２内にはピストン１６が摺動可能に嵌合しているとともに、シリンダヘッド１４の下面とピストン１６上面との間に、いわゆるペントルーフ型の燃焼室１８が形成されている。この燃焼室１８の一方の傾斜面１８ａには第１吸気通路２０及び第２吸気通路２２が開口しており、他方の傾斜面１８ｂに第１排気通路２４及び第２排気通路２６が開口している。

【００１３】また、燃焼室１８には、第１，第２吸気通路２０，２２との間をそれぞれ開閉する第１吸気弁２８及び第２吸気弁３０と、第１，第２排気通路２４，２６との間をそれぞれ開閉する第１排気弁３２及び第２排気弁３４が設けられ、これら吸気弁２８，３０及び排気弁３２，３４によって囲まれたシリンダ１２の略中心位置に、点火プラグ３６が配設されている。吸気通路２０，２２は、上流側で互いに合流しており、その合流部３８に、電磁式の燃料噴射弁４０が設けられている。

【００１４】第１，第２排気通路２４，２６は、それぞれシリンダヘッド１４内部に穿設された一対の排気ポートからシリンダヘッド１４に取り付けられる第１排気管４２及び第２排気管４４の内部にわたって互いに独立して延びている。そして、第２排気管４４の途中には、第２排気通路２６を開閉するバタフライバルブ型の制御弁４６が介装されている。この制御弁４６は、シャフト４８を介して図示せぬ駆動機構によって機関運転条件に応じて開閉制御される。

【００１５】図３は、吸気弁２８，３０及び排気弁３２，３４のバルブリフト特性を示している。これらの吸気弁２８，３０及び排気弁３２，３４は、それぞれ機関のクランクシャフトと同期して回転するカムのプロフィールに応じて開閉作動する。

【００１６】吸気弁２８，３０を駆動するカムシャフトには、カムひねり機構５０が設けられており、カムシャフトと図示しないクランクシャフトとの回転位相を変更することができる。このカムひねり機構５０の作動範囲の一例を図４に示す。自己着火を起こすような高圧縮比、例えば１４～１８を実現する場合は、吸気バルブタイミング１となり、上死点ＴＤＣより前に吸気弁２８，３０が開弁し、下死点ＢＤＣ付近で、吸気弁２８，３０が閉弁する。自己着火が起きず、火花点火においてもノッキングが起きないような低圧縮比、例えば１２以下、を実現する場合は、吸気バルブタイミング２となり、上死点ＴＤＣ付近で吸気弁２８，３０が開弁し、下死点ＢＤＣを大きく過ぎた角度で吸気弁２８，３０が閉弁するよう構成されている。

【００１７】各吸気弁２８，３０及び排気弁３２，３４の開閉動作を図５、図６を参照して説明すると、図３（イ）に示す第１排気弁３２は、排気行程（ａ）付近で開作動し、その他の吸気行程（ｂ）、圧縮行程（ｃ）及び膨張行程（ｄ）の付近では閉状態に制御されている。

【００１８】一方、図３（ロ）に示す第２排気弁３４は、排気行程（ａ）及び吸気行程（ｂ）付近の両方で開作動し、圧縮行程（ｃ）及び膨張行程（ｄ）付近では、閉状態に制御される。つまり、第２排気弁３４は、通常の第１排気弁３２とともに、排気行程（ａ）付近で開作動するとともに、吸気弁２８，３０とともに吸気行程（ｂ）付近で開作動し排気行程（ａ）から吸気行程（ｂ）にまたがって開状態に保持されることとなる。

【００１９】また、吸気弁２８，３０は、図３（ハ）に示すように、吸気行程（ｂ）付近で開作動し、その他の排気行程（ａ）、圧縮行程（ｃ）及び膨張行程（ｄ）の付近では、閉状態に制御される。つまり、吸気行程（ｂ）では、両吸気弁２８，３０と、第２排気弁３４とが同期して開作動する。

【００２０】例えば図７に斜線の領域で示す部分負荷時には、吸気弁２８，３０は図４の吸気バルブタイミング１に設定されシリンダ１２内は、高圧縮比になる。この時、図５に示すように、制御弁４６は開状態に制御され、自己着火燃焼が行われる。詳述すると、排気行程（ａ）では、両方の排気通路２４，２６が開作動し、ピストン１６の上昇に伴って燃焼室１８内の既燃ガスが両排気通路２４，２６を通って排出される。続く吸気行程（ｂ）では、上述したように吸気弁２８，３０及び第２排気弁３４がともに開作動する。従って燃焼室１８には、ピストン１６の下降に伴って新気（混合気）Ｐが吸気通路２０，２２側から導入されると同時に、第２排気通路２６内に残留する既燃ガスＱが導入される。ここで、燃焼室１８は、いわゆるクロスフロー形式となっており、吸気通路２０，２２が開口する側と排気通路２４，２６が開口する側とが略対称形に形成され、かつ、ピストン１６の上面が略平面に形成されているため、吸気通路２０，２２から導入される混合気Ｐがそのまま吸気通路２０，２２側に残留し、第２排気通路２６から導

入される既燃ガスＱがそのまま排気通路２４，２６側に残留する。従って、燃焼室１８内は、混合気Ｐと既燃ガスＱとが成層化した状態となる。なお、この吸気行程（ｂ）では、第１排気弁３２（図３）は開状態となっており、第１排気通路２４内に残留する既燃ガスＱが燃焼室１８へ逆流することはない。続く圧縮行程（ｃ）では、燃焼室１８内の混合気Ｐと既燃ガスＱとが成層化した状態で圧縮される。このため、燃焼室１８内に残留する既燃ガスＱの温度が、断熱圧縮の作用によって混合気Ｐの発火温度を越えるまで上昇し、混合気Ｐと残留既燃ガスＱとの界面において、残留既燃ガスＱから混合気Ｐへの自己着火が行われる。そして膨張行程（ｄ）では、爆発圧力によりピストン１６が下死点ＢＤＣ側へ押し下げられて、再び排気行程（ａ）へと戻り、上述した動作が繰り返される。

【００２１】一方、機関の運転が部分負荷領域を外れた場合には、吸気弁２８，３０は図４の吸気バルブタイミング２に示すように設定され、シリンダ１２内は、自己着火が起きずノッキングも起きない低圧縮比になる。この際、図２に示すように、制御弁４６は全開状態に制御され、シリンダ１２内に均質な混合気Ｐを形成して点火する均質燃焼が行われる。詳述すると、排気行程（ａ）では第１排気通路２４（図３）を通って燃焼室１８内の既燃ガスＱが排出され、吸気行程（ｂ）では両吸気弁２８，３０が開状態となり、両吸気通路２０，２２から混合気Ｐが燃焼室１８内に導入される。このとき、制御弁４６が開状態となっているから、第２排気通路２６から既燃ガスＱが導入されることはない。続く圧縮行程（ｃ）で圧縮された混合気Ｐは点火プラグ３６で着火され、膨張行程（ｄ）では爆発圧力によりピストン１６が押し下げられる。

【００２２】ここで、自己着火領域と火花点火領域の両領域間の移行について述べる。図８に示すように、加速時など、部分負荷の自己着火領域から、負荷や回転が増大し、火花点火運転領域に移行する場合は、その判定負荷と回転数とを、その反対の減速時の場合よりも、高くする。これにより、この負荷と回転付近の運転時において、負荷と回転とが変動する際、頻繁に自己着火と均質燃焼が変化するのを防ぐことができる。機関の運転の円滑、安定を実現でき、かつ、作動機構の耐久性も向上できる。

【００２３】また、図９に示すように、負荷と回転数とがあらかじめ定められた自己着火領域になった場合にも、その後一定の時間、負荷や回転が略一定になっているかどうかを確認後、自己着火運転に移行することも考えられる。これにより、急激なアクセルペダルの開閉やエンジン回転の上下により、頻繁に自己着火と火花点火とを切換えることが防止され、安定した運転が期待できる。この際、自己着火運転に入った後、負荷や回転が高くなり火花点火運転に移行する際は、このような略一定の運転かどうかの確認をせず、即座に火花点火運転に移行する。これにより、負荷増大の応答性を高くすることができ、加速等のときのレスポンスを向上できる。

【００２４】このような、自己着火と火花点火の運転領域の切換えの際、圧縮比を制御する吸気カムひねり機構５０と、燃焼室１８内に残留させる既燃ガスＱの量を制御する制御弁４６の作動について述べる。基本的には、自己着火領域は部分負荷なので、吸気管負圧が低く、シリンダ１２内の圧力も低いため、圧縮比を高めても残留ガスが少ない限り、ノッキングは起こりにくい。また、既燃ガスＱが大量にシリンダ１２に流入すると、圧縮比が自己着火が起こるような１４以下である場合には、火花点火運転しなくてはいけないが、このような大量の残留既燃ガスＱがある場合は、燃焼が不安定となりがちでエンジンの運転が不安定がちとなり、長い時間この状態にエンジンがあることは好ましくない。従って、火花点火運転領域から自己着火運転領域に移行する際は、図１０に示すように、まず、時間のかかる吸気弁２８，３０のひねりを先行させ、圧縮比が高くなってから、応答速度の早い制御弁４６を開けて既燃ガスＱをシリンダ１２内に導入すると、移行の際のノッキングの発生や、燃焼の不安定が抑制されて、移行が円滑に、安定に行うことができる。つまり、システム応答速度の劣る圧縮比を先に高めてから、その後、システム応答速度の早い内部ＥＧＲガスを導入するように、カムひねり機構５０と、制御弁４６の作動を制御する。その後、自己着火が確認されれば、図示しないが、点火プラグ３６を休止してもよい。

【００２５】反対に、自己着火領域から火花点火運転領域に移行する際は、図示しないが、図１０で示したこの順番とは逆にする。つまり、まず火花点火を再開し、ついで既燃ガスＱのシリンダ１２内への流入を止め、その後、カムひねり機構５０により、圧縮比を低下させる。これにより、加速開始直後の既燃ガスＱによる火花点火時の燃焼不安定が抑制されるとともに、高圧縮比のまま残留既燃ガスＱがなくなることによりトルクが増大し、加速感の向上が得られる。その後は吸気側のスロットルの開度が開くことが現れて吸気量自体が増大するので、低圧縮比でも出力を増大できる。

【００２６】以上のように、本実施の形態にかかる４ストローク型の火花点火式エンジンでは、部分負荷時における実圧縮比が高く設定され、しかも、吸気行程（ｂ）の際に、第２排気通路２６に残留する既燃ガスＱが燃焼室１８へ導入されるため、燃焼室１８内で既燃ガスＱ側から混合気Ｐへの自己着火が可能となり、良好な自己着火燃焼が実現される。この結果、従来のように吸気通路の途中に設けられたスロットル弁によって、部分負荷時に吸入される新気の量を制限する必要がないため、吸入負圧に起因するポンピングロスの低減が可能となる。

【００２７】また、部分負荷以外の運転領域において

は、圧縮比を低くし、制御弁４６を閉じて第２排気通路２６を遮断することにより、上述したように吸気行程（ｂ）で既燃ガスＱが第２排気通路２６から燃焼室１８へ導入されることはなく、ノッキングを抑制でき、十分に良好な出力を得ることができる。

【００２８】また、自己着火領域と火花点火領域との切換えの際、火花点火から自己着火に切換える際は、まず圧縮比を高め、ついで、既燃ガスＱを導入するよう、カムひねり機構５０と制御弁４６の作動に時間差を設けたので、既燃ガスＱによる火花点火時の燃焼不安定が抑制され、エンジンの円滑な安定な運転が実現できる。また、自己着火から火花点火に移行する際は、その逆で、まず燃焼室１８内への既燃ガスＱの導入を止め、ついで圧縮比を低くするので、既燃ガスＱ存在下での火花点火燃焼が少なく、しかも、高圧縮比のまま残留ガスの少ない火花点火になるので、トルクも増大し、加速感の向上が得られる。つまり本実施の形態では、部分負荷時における自己着火燃焼と高負荷時における均質燃焼とを高度に両立させることができる。

【００２９】なお、本実施の形態は、排気弁（第１排気弁３２、第２排気弁３４）を２弁設け、片方の排気弁（第２排気弁３４）を吸気行程にも開状態とし、排気通路の開閉弁により燃焼室１８内に残留する既燃ガスＱを制御するような自己着火機構を用いて説明したが、本発明はこれに限定されるものではなく、例えば、排気側にも可変動弁機構を設けて排気弁の閉じ時期を早めることにより既燃ガスＱの一部を燃焼室内に残留させるものに適用しても良い。さらには、残留既燃ガスＱの制御によって自己着火を制御するものに限定されるものでもなく、要するに、自己着火燃焼と火花点火燃焼とを両立させる際に圧縮比を変更しようとする機関には全て適用可能である。

【００３０】また、実圧縮比を変更する可変動弁機構として吸気カムシャフトと機関のクランクシャフトとの位相を変更する機構を用いているが、２種類以上のカムを切換えてバルブリフト特性を変更する動弁系やクランクシャフトに対するカムシャフトの角速度を変更して開弁機関を連続的に変更可能な動弁系、電磁力あるいは油圧によって開閉時期を自由に制御することが可能な動弁系等を使用しても良いことはもちろんである。

【００３１】

【発明の効果】以上のように、本発明によれば、自己着火燃焼と火花点火燃焼の両方の燃焼とも良好に行わせることができるとともに、機関の耐久性や燃焼ガスのシール性を容易に確保することができる。

【図面の簡単な説明】

【図１】本発明実施の形態の構成例の一例を示す図である。

【図２】実施の形態の構成例の一例を示す図である。

【図３】実施の形態の吸気弁と排気弁の作動の一例を示す図である。

【図４】実施の形態の自己着火時と火花点火時との吸気可変動弁の作動例を示す図である。

【図５】実施の形態の部分負荷の動作を示す図である。

【図６】実施の形態の高負荷時の動作を示す図である。

【図７】実施の形態の自己着火運転領域を示す図である。

【図８】実施の形態の加減速時の自己着火判断領域の一例を示す図である。

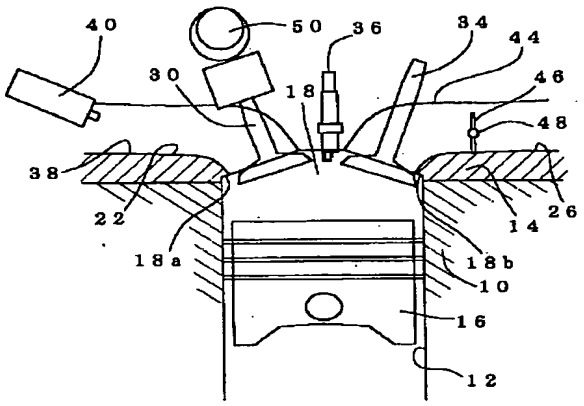
【図９】実施の形態の自己着火燃焼指示のその他の一例を示す図である。

【図１０】実施の形態の自己着荷領域への移行時のバルブひねりと排気制御弁の動きの一例を示す図である。

【符号の説明】

１０　シリンダブロック
１２　シリンダ
１４　シリンダヘッド
１６　ピストン
１８　燃焼室
１８ａ　傾斜面
１８ｂ　傾斜面
２０　第１吸気通路
２２　第２吸気通路
２４　第１排気通路
２６　第２排気通路
２８　第１吸気弁
３０　第２吸気弁
３２　第１排気弁
３４　第２排気弁
３６　点火プラグ
３８　合流部
４０　燃料噴射弁
４２　第１排気管
４４　第２排気管
４６　制御弁
４８　シャフト
５０　カムひねり機構

【図１】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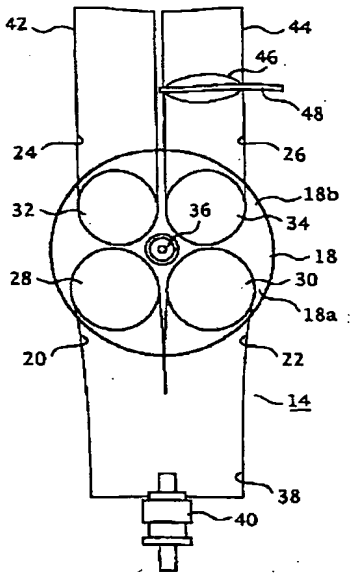
【図２】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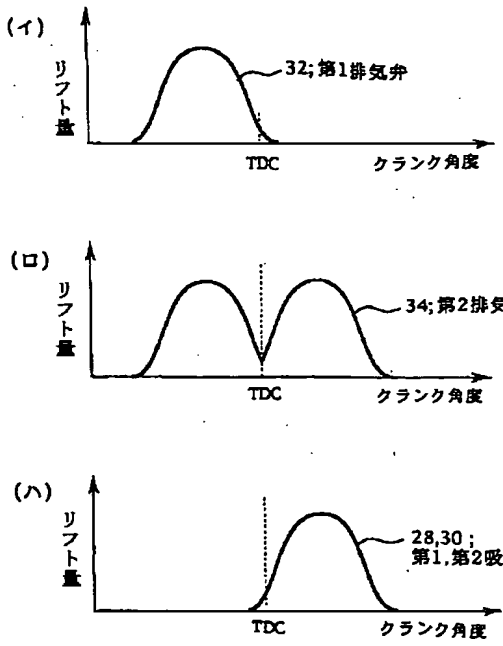
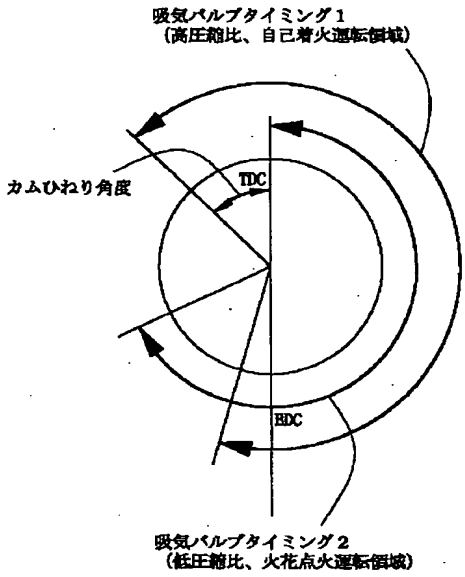
38
40

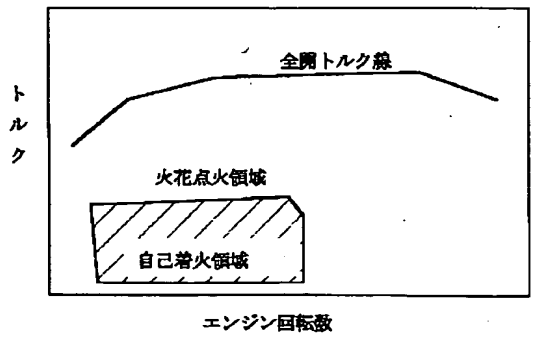
【図３】


(イ)
リフト量
32;第1排気弁
TDC
クランク角度
(ロ)
リフト量
34;第2排気弁
TDC
クランク角度
(ハ)
リフト量
28,30;
第1,第2吸気弁
TDC
クランク角度

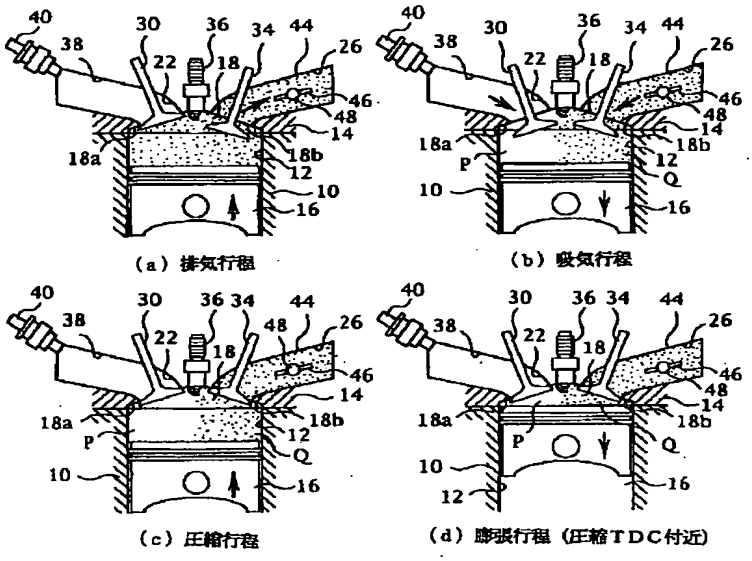
【図４】


吸気バルブタイミング１
（高圧縮比、自己着火運転領域）
カムひねり角度
TDC
BDC
吸気バルブタイミング２
（低圧縮比、火花点火運転領域）

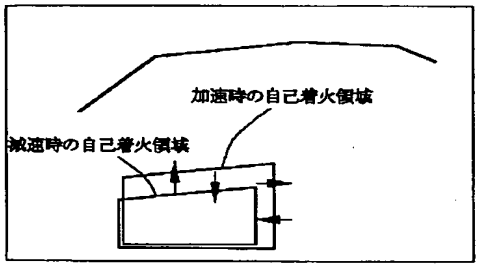
【図７】


全開トルク線
トルク
火花点火領域
自己着火領域
エンジン回転数

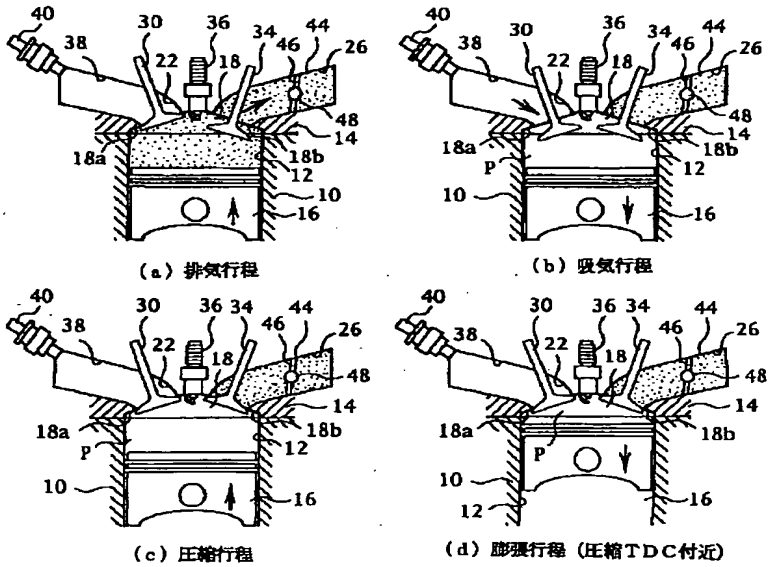
【図５】


40
38
30
36
34
44
26
22
18
46
48
14
18a
18b
12
10
16
P
Q
(a) 排気行程
(b) 吸気行程
(c) 圧縮行程
(d) 膨張行程（圧縮ＴＤＣ付近）

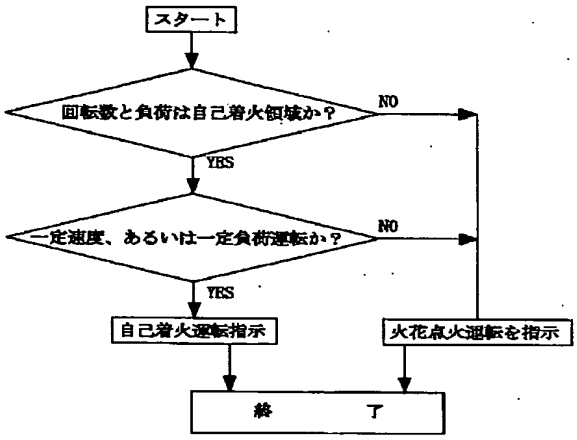
【図８】


加速時の自己着火領域
減速時の自己着火領域

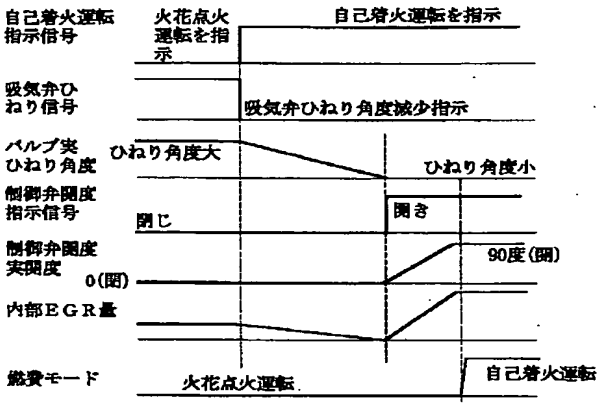
【図６】


40
38
30
36
34
46
44
26
22
18
48
14
18a
18b
12
10
16
P
(a) 排気行程
(b) 吸気行程
(c) 圧縮行程
(d) 膨張行程（圧縮ＴＤＣ付近）

【図９】


スタート
回転数と負荷は自己着火領域か？
NO
YES
一定速度、あるいは一定負荷運転か？
NO
YES
自己着火運転指示
火花点火運転を指示
終　了

【図１０】


自己着火運転指示信号
火花点火運転を指示
自己着火運転を指示
吸気弁ひねり信号
吸気弁ひねり角度減少指示
バルブ実ひねり角度
ひねり角度大
ひねり角度小
制御弁開度指示信号
閉じ
開き
制御弁開度実開度
0(閉)
90度(開)
内部ＥＧＲ量
燃費モード
火花点火運転
自己着火運転

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to amelioration of the jump-spark-ignition type internal combustion engine which makes both self-ignition combustion and jump-spark-ignition combustion perform according to a operating range.
[0002]
[Description of the Prior Art] In the field of the internal combustion engine of a two-cycle mold, in order to aim at coexistence with the compression ratio which various proposals are made about the engine which makes self-ignition combustion perform by the low load operating range, for example, was suitable for self-ignition combustion at JP,9-242570,A, and the compression ratio suitable for the usual jump-spark-ignition combustion, what changes volume of combustion chamber according to operational status is indicated.
[0003]
[Problem(s) to be Solved by the Invention] These people have proposed effective technology previously especially, when applying such self-ignition to the internal combustion engine of a four-cycle mold (Japanese Patent Application No. No. 296567 [nine to] etc.). although it is desirable to consider as the compression ratio for which it resembled to make both self-ignition combustion and jump-spark-ignition combustion perform good also in the internal combustion engine of a four-cycle mold, respectively, and was suitable, when preparing moving-part material in the part which receives a firing pressure directly like the above-mentioned conventional technology and making a compression ratio adjustable, the endurance reservation for moving part, seal nature reservation of the combustion gas for moving part, etc. become difficult.
[0004] By the way, it is possible to change a substantial compression ratio by changing the closing motion stage of an inlet valve in the engine which changes with the closing motion stages of the inlet valve which the charging efficiency of the new mind to a combustion chamber or gaseous mixture with a fuel drives synchronizing with rotation of an engine like the common internal combustion engine of a four-cycle mold. This invention aims at offering the jump-spark-ignition type internal combustion engine which makes combustion of both self-ignition combustion and jump-spark-ignition combustion perform good on the assumption that the internal combustion engine which has the inlet valve driven synchronizing with rotation of an engine.
[0005]
[Means for Solving the Problem] Then, it sets to a jump-spark-ignition type internal combustion engine which invention of claim 1 makes self-ignition combustion perform [internal combustion engine] by predetermined operating range, and makes jump-spark-ignition combustion perform by operating range other than said predetermined operating range. An inlet valve and an exhaust valve which open and close an inhalation-of-air path and a flueway which carry out a opening to a combustion chamber synchronizing with rotation of an engine, respectively, By changing a closing motion stage of said inlet valve, it has an adjustable valve gear which changes an engine's real compression ratio, and is

characterized by changing a real compression ratio at the time of self-ignition combustion, and a real compression ratio at the time of jump-spark-ignition operation by this adjustable valve gear.
[0006] Specifically, a real compression ratio at the time of self-ignition combustion is made higher than a real compression ratio at the time of jump-spark-ignition operation like invention according to claim 2. In this case, a stroke of an engine's diameter of a boa or a piston, capacity of a combustion chamber, etc. are eternal, and since it is not necessary to complicate structure of the circumference of a combustion chamber, an engine's endurance and the seal nature of combustion gas are easily securable. Moreover, by compression stroke at a time of making self-ignition combustion perform, since it is changed so that a real compression ratio may be suitable for each combustion condition, when the temperature up of the gas of a combustion chamber is carried out by high real compression ratio good and jump-spark-ignition combustion is made to perform with it, generating of knocking is controlled by real compression ratio lower than the time of self-ignition combustion good.
[0007] A jump-spark-ignition plug arranged in the center of cylinder abbreviation like invention according to claim 3 in detail, An inhalation-of-air path and a flueway which carry out a opening to a combustion chamber, and an inlet valve and an exhaust valve which open and close said inhalation-of-air path and flueway synchronizing with rotation of an engine, respectively, An adjustable valve gear which changes an engine's real compression ratio by changing a closing motion stage of said inlet valve, It has a burnt-gas residual means to make a part of burnt gas remain to a combustion chamber. In a predetermined operating range Self-ignition combustion is made to perform by raising an engine's real compression ratio by said good fluctuation valve system, while making a part of burnt gas remain to a combustion chamber with said burnt-gas residual means. While decreasing a residual of a burnt gas by said burnt-gas residual means, an engine's real compression ratio is reduced by said good fluctuation valve system, and jump-spark-ignition combustion by said jump-spark-ignition plug can be made to perform in operating range other than said predetermined operating range. When making self-ignition combustion perform, a temperature up is carried out by high compression ratio of the above-mentioned [a burnt gas which remained to a combustion chamber] good by compression stroke, and self-ignition combustion by which this became charcoal and was stabilized is realized.
[0008] In order to make a burnt gas remain to a combustion chamber, it realizes like invention according to claim 4 by bringing a closing stage of an exhaust valve forward by the 2nd adjustable valve gear. Or the 2nd flueway in which said burnt-gas residual means was able to be formed independently of said flueway like invention according to claim 5, The 2nd exhaust valve which opens said 2nd flueway by an engine's exhaust stroke and an intake stroke, It is not concerned with rotation of an engine. A closing motion means which can open and close said 2nd flueway, since -- it constitutes, a burnt gas discharged by said 2nd flueway in an exhaust stroke by open Lycium chinense in said closing motion means is introduced into an intake stroke at a combustion chamber, and a part of burnt gas can be made to remain to a combustion chamber In this case, a burnt gas introduced into a combustion chamber comes to be unevenly distributed by combustion chamber from new mind (gaseous mixture) introduced into a combustion chamber from an inhalation-of-air path, and the 2nd flueway, and self-ignition from an exhaust side to an inspired air flow path is performed. A combustion chamber is good to consider as the so-called cross-flow format that a side said flueway carries out [a side] a opening like invention according to claim 6 a side in which said inhalation-of-air path carries out a opening was formed in an abbreviation symmetry form here. Thereby, new mind (gaseous mixture) and a burnt gas are stratification-ized by combustion chamber, and self-ignition is performed still better in the interface.
[0009] Moreover, by changing a phase of an inhalation-of-air cam shaft which drives said inlet valve, and an engine's crankshaft like invention according to claim 7, an adjustable valve gear carries out the tooth lead angle of the valve timing of said inlet valve, raises an engine's real compression ratio, by operating range other than said predetermined operating range, can carry out the lag of the valve timing of said inlet valve, and can reduce an engine's real compression ratio at said predetermined operating range.
[0010] When an engine's service condition changes between said predetermined operating range and the other operating range, he is trying to change an actuation stage of said burnt-gas residual means, and an

actuation stage of said good fluctuation valve in invention according to claim 8. The amount of residuals and a compression ratio of a burnt gas have big influence on both an engine's combustion, and it is necessary to make these change to suitable timing. Usually, neither a burnt-gas residual means nor an adjustable valve gear may operate that it is also at a certain speed so that it may be switched in an instant, and this speed may change in the state of an engine. Although a condition of the amount of burnt-gas residuals which cannot be expected from change over initiation before completion, and a compression ratio will be passed when switching self-ignition combustion and jump-spark-ignition combustion and such two means are operated to coincidence, two combustion conditions can be switched smoothly, without producing such a problem by changing both actuation stage.
[0011] moreover, in the actuation section of a burnt-gas residual means being a closing motion means and being the device in which an adjustable valve gear changes a phase of an inhalation-of-air cam shaft and an engine's crankshaft When an engine's service condition changes from operating range other than said predetermined operating range to said predetermined operating range, after carrying out the tooth lead angle of the valve timing of said inlet valve like invention according to claim 9, said closing motion means An aperture, When an engine's service condition changes from said predetermined operating range to the other operating range, after closing said closing motion means, it is good to control said good fluctuation valve system and said closing motion means to carry out the lag of the valve timing of said inlet valve. In addition, a predetermined operating range to which self-ignition combustion is made to perform can be set as a partial load field like invention according to claim 10. Moreover, like invention according to claim 11, if a hysteresis field is set as the perimeter of a predetermined operating range, frequent change over of two combustion conditions is controlled, and an engine can be operated more smoothly.
[0012]
[Embodiment of the Invention] Next, the gestalt of the operation which applied this invention to the gasoline engine for automobiles of the four-cycle mold which is a jump-spark-ignition type internal combustion engine is explained to details based on an accompanying drawing. As shown in drawing 1 and 2, two or more cylinders 12 are arranged at the serial, and the cylinder head 14 is being fixed to the cylinder block 10 so that the upper surface may be covered. While the piston 16 has fitted in possible [sliding] in a cylinder 12, the so-called PENTO roof type of combustion chamber 18 is formed between the inferior surface of tongue of the cylinder head 14, and the piston 16 upper surface. The 1st inhalation-of-air path 20 and the 2nd inhalation-of-air path 22 are carrying out the opening to one inclined plane 18a of this combustion chamber 18, and the 1st flueway 24 and the 2nd flueway 26 are carrying out the opening to inclined plane 18b of another side.
[0013] Moreover, the 1st inlet valve 28 and the 2nd inlet valve 30 which open and close between the 1st and 2nd inhalation-of-air paths 20 and 22, respectively, and the 1st exhaust valve 32 and the 2nd exhaust valve 34 which open and close between the 1st and 2nd flueway 24 and 26, respectively are prepared in a combustion chamber 18, and the ignition plug 36 is arranged in the abbreviation center position of the cylinder 12 surrounded with these inlet valves 28 and 30 and exhaust valves 32 and 34. The inhalation-of-air paths 20 and 22 join mutually by the upstream, and the electromagnetic fuel injection valve 40 is formed in the unification section 38.
[0014] From the exhaust air port of the pair drilled in the cylinder head 14 interior, respectively, over the interior of the 1st exhaust pipe 42 attached in the cylinder head 14, and the 2nd exhaust pipe 44, mutually-independent [of the 1st and 2nd flueway 24 and 26] was carried out, and it has extended. And in the middle of the 2nd exhaust pipe 44, the control valve 46 of the butterfly valve mold which opens and closes the 2nd flueway 26 is infixed. According to an engine service condition, closing motion control of this control valve 46 is carried out by the drive which is not illustrated through a shaft 48.
[0015] Drawing 3 shows the valve-lift property of inlet valves 28 and 30 and exhaust valves 32 and 34. These inlet valves 28 and 30 and exhaust valves 32 and 34 carry out closing motion actuation according to the profile of a cam which rotates synchronizing with an engine's crankshaft, respectively.
[0016] the cam twist device 50 is formed in the cam shaft which drives inlet valves 28 and 30, and the rotation phase of a cam shaft and the crankshaft which is not a drawing example can be changed into it.

An example of the actuation range of this cam twist device 50 is shown in drawing 4 . When realizing a high compression ratio, 14-18, which causes self-ignition, it becomes the inhalation-of-air valve timing 1, and inlet valves 28 and 30 open before a top dead center TDC, it is near bottom dead point BDC, and inlet valves 28 and 30 close the valve. [for example,] When realizing a low compression ratio (12 or less [for example,]) in which self-ignition does not occur and knocking does not occur in jump spark ignition, it becomes the inhalation-of-air valve timing 2, and inlet valves 28 and 30 open near top dead center TDC, and it is constituted so that inlet valves 28 and 30 may close the valve at the angle which passed the bottom dead point BDC greatly.

[0017] If the switching action of each inlet valves 28 and 30 and exhaust valves 32 and 34 is explained with reference to drawing 5 and drawing 6 , the 1st exhaust valve 32 shown in the drawing 3 (**) carries out open actuation near an exhaust stroke (a), and is controlled near other intake strokes (b), the compression stroke (c), and the expansion stroke (d) by the closed state.

[0018] On the other hand, the 2nd exhaust valve 34 shown in the drawing 3 (**) carries out open actuation by both an exhaust stroke (a) and near an intake stroke (b), and is controlled a compression stroke (c) and near an expansion stroke (d) by the closed state. That is, with the 1st usual exhaust valve 32, while the 2nd exhaust valve 34 carries out open actuation near an exhaust stroke (a), it will carry out open actuation near an intake stroke (b), and will be held [inlet valves / 28 and 30] at an open condition ranging over an intake stroke (b) from an exhaust stroke (a).

[0019] Moreover, to be shown in drawing 3 (Ha), inlet valves 28 and 30 carry out open actuation near an intake stroke (b), and are controlled near other exhaust strokes (a), a compression stroke (c), and an expansion stroke (d) by the closed state. That is, in an intake stroke (b), both the inlet valves 28 and 30 and the 2nd exhaust valve 34 synchronize and carry out open actuation.

[0020] For example, at the time of the partial load shown in drawing 7 in the field of a slash, inlet valves 28 and 30 are set as the inhalation-of-air valve timing 1 of drawing 4 , and become a high compression ratio in a cylinder 12. At this time, as shown in drawing 5 , a control valve 46 is controlled by the open condition and self-ignition combustion is performed. If it explains in full detail, in an exhaust stroke (a), both flueways 24 and 26 will carry out open actuation, and the burnt gas in a combustion chamber 18 will be discharged through both the flueways 24 and 26 with a rise of a piston 16. In the continuing intake stroke (b), as mentioned above, both the inlet valves 28 and 30 and the 2nd exhaust valve 34 carry out open actuation. Therefore, burnt-gas Q which remains in the 2nd flueway 26 is introduced into a combustion chamber 18 at the same time the new mind (gaseous mixture) P is introduced from inhalation-of-air path 20 and 22 side with descent of a piston 16. Since the combustion chamber 18 serves as the so-called cross-flow format, and the side flueways 24 and 26 carry out [a side] a opening the side in which the inhalation-of-air paths 20 and 22 carry out a opening is formed in an abbreviation symmetry form here and the upper surface of a piston 16 is formed in the abbreviation plane, the gaseous mixture introduced from the inhalation-of-air paths 20 and 22 -- P remains to inhalation-of-air path 20 and 22 side as it is, and burnt-gas Q introduced from the 2nd flueway 26 remains to flueway 24 and 26 side as it is. therefore, the inside of a combustion chamber 18 -- gaseous mixture -- P and burnt-gas Q will be in the condition of having stratification-ized. In addition, in this intake stroke (b), the 1st exhaust valve 32 (drawing 3) is in the open condition, and burnt-gas Q which remains in the 1st flueway 24 does not flow backwards to a combustion chamber 18. the continuing compression stroke (c) -- the gaseous mixture in a combustion chamber 18 -- P and burnt-gas Q are compressed in the condition of having stratification-ized. for this reason, the temperature of burnt-gas Q which remains in a combustion chamber 18 -- an operation of adiabatic compression -- gaseous mixture -- until it exceeds the ignition temperature of P -- going up -- gaseous mixture -- the interface of P and residual burnt-gas Q -- setting -- the gaseous mixture from residual burnt-gas Q -- self-ignition to P is performed. And in an expansion stroke (d), a piston 16 is depressed by explosion pressure to a bottom dead point BDC side, and return and the actuation mentioned above are repeated again to an exhaust stroke (a).

[0021] On the other hand, when operation of an engine separates from a partial load field, inlet valves 28 and 30 are set up as shown in the inhalation-of-air valve timing 2 of drawing 4 , and the inside of a cylinder 12 becomes the low compression ratio in which self-ignition does not occur and knocking does

not occur, either. under the present circumstances, a control valve 46 is controlled in the full open condition to be shown in drawing 2 -- having -- gaseous mixture homogeneous in a cylinder 12 -- homogeneity combustion which forms P and lights it is performed. If it explains in full detail, burnt-gas Q in a combustion chamber 18 is discharged through the 1st flueway 24 (drawing 3), by the exhaust stroke (a), by the intake stroke (b), both the inlet valves 28 and 30 will be in an open condition, and gaseous mixture P will be introduced in a combustion chamber 18 from both the inhalation-of-air paths 20 and 22. Since the control valve 46 is in the open condition at this time, burnt-gas Q is not introduced from the 2nd flueway 26. the gaseous mixture compressed by the continuing compression stroke (c) -- P is lit with an ignition plug 36 and a piston 16 is depressed by explosion pressure in an expansion stroke (d).

[0022] Here, the shift between both the fields of a self-ignition field and a jump-spark-ignition field is described. As shown in drawing 8 , when a load and rotation increase and shift to a jump-spark-ignition operating range from the self-ignition field of partial loads, such as the time of acceleration, the judgment load and rotational frequency are made higher than the case at the time of the opposite moderation. Thereby, in case a load and rotation are changed at the time of operation this load and near rotation, it can prevent self-ignition and homogeneity combustion changing frequently. Smoothness of operation of an engine and stability can be realized and the endurance of an operation system can also improve.

[0023] Moreover, as shown in drawing 9 , also when a load and a rotational frequency become the self-ignition field appointed beforehand, shifting to self-ignition operation is also considered after checking whether fixed time amount, a load, and rotation are abbreviation regularity after that. Operation by which the thing of closing motion of a rapid accelerator pedal or engine rotation for which self-ignition and jump spark ignition are switched up and down more frequently was prevented, and was stabilized by this is expectable. Under the present circumstances, in case a load and rotation become high and shift to jump-spark-ignition operation after starting self-ignition operation, it does not check that it is operation of such abbreviation regularity, and shifts to jump-spark-ignition operation immediately. Thereby, responsibility of load increase can be made high and the response at the times, such as acceleration, can be improved.

[0024] Actuation of the control valve 46 which controls the air inlet cam twist device 50 which controls a compression ratio, and the amount of burnt-gas Q made to remain in a combustion chamber 18 is described in the case of the change of the operating range of such self-ignition and jump spark ignition. Fundamentally, since a self-ignition field is a partial load, inlet-pipe negative pressure is low, and since the pressure in a cylinder 12 is also low, even if it raises a compression ratio, as long as there is little residual gas, knocking cannot take place easily. Moreover, when burnt-gas Q flows into a cylinder 12 in large quantities and a compression ratio is 14 or less [to which self-ignition happens], jump-spark-ignition operation must be carried out, but when there is such a lot of residual burnt-gas Q, it is not desirable that combustion tends to become unstable, instability serves as [operation of an engine] **, and an engine is in this condition long time. Therefore, if the control valve 46 with an early speed of response is opened and burnt-gas Q is introduced in a cylinder 12 after it makes the twist of the inlet valves 28 and 30 which time amount requires precede first and a compression ratio becomes high as shown in drawing 10 in case it shifts to a self-ignition operating range from a jump-spark-ignition operating range, generating of knocking in the case of shift and the instability of combustion are controlled, and shift can carry out to stability smoothly. That is, after raising previously the compression ratio in which system response speed is inferior, the cam twist device 50 and actuation of a control valve 46 are controlled to introduce internal EGR gas with an early system response speed after that. Then, although it will not illustrate if self-ignition is checked, an ignition plug 36 may be stopped.

[0025] Although it does not illustrate on the contrary in case it shifts to a jump-spark-ignition operating range from a self-ignition field, it carries out to this sequence shown by drawing 10 at reverse. That is, jump spark ignition is resumed first and, subsequently an inflow into the cylinder 12 of burnt-gas Q reduces a compression ratio according to the cam twist device 50 a stop and after that. Thereby, while the combustion instability at the time of jump spark ignition by burnt-gas Q immediately after

acceleration initiation is controlled, when residual burnt-gas Q is lost with a high compression ratio, torque increases and improvement in a feeling of acceleration is obtained. Since open Lycium chinense appears [the opening of the throttle of an inspired air flow path] and the amount of inhalation of air itself increases after that, an output can be increased also with a low compression ratio.

[0026] As mentioned above, with the jump-spark-ignition type engine of 4 stroke molds concerning the gestalt of this operation, the real compression ratio at the time of a partial load is set up highly, moreover, since burnt-gas Q which remains to the 2nd flueway 26 in the case of an intake stroke (b) is introduced to a combustion chamber 18, the self-ignition from the burnt-gas Q side to gaseous mixture P becomes possible in a combustion chamber 18, and good self-ignition combustion is realized. Consequently, since the throttle valve prepared in the middle of the inhalation-of-air path like before does not need to restrict the amount of the new mind inhaled at the time of a partial load, reduction of the pumping loss resulting from inhalation negative pressure is attained.

[0027] Moreover, in operating range other than a partial load, by making a compression ratio low, closing a control valve 46, and intercepting the 2nd flueway 26, as mentioned above, burnt-gas Q is not introduced from the 2nd flueway 26 by the intake stroke (b) to a combustion chamber 18, knocking can be controlled, and an output good enough can be obtained.

[0028] Moreover, since time difference was prepared in actuation of the cam twist device 50 and a control valve 46 so that a compression ratio might be raised first and burnt-gas Q might subsequently be introduced when switching to self-ignition from jump spark ignition at the time of a change with a self-ignition field and a jump-spark-ignition field, the combustion instability at the time of jump spark ignition by burnt-gas Q is controlled, and smooth stable operation of an engine can be realized. Moreover, since it is the reverse, installation of burnt-gas Q into a combustion chamber 18 is stopped first and a compression ratio is subsequently made low in case it shifts to jump spark ignition from self-ignition, there is little jump-spark-ignition combustion under burnt-gas Q existence, since it becomes jump spark ignition with little residual gas with a high compression ratio, torque also increases and improvement in a feeling of acceleration is obtained. That is, with the gestalt of this operation, the self-ignition combustion at the time of a partial load and the homogeneity combustion at the time of a heavy load can be reconciled in altitude.

[0029] In addition, although the gestalt of this operation was explained using a self-ignition device which controls burnt-gas Q which makes an open condition an exhaust valve (the 1st exhaust valve 32, the 2nd exhaust valve 34) also at an intake stroke, and remains the exhaust valve (the 2nd exhaust valve 34) of 2 ****** and one of the two in a combustion chamber 18 by the open clausilium of a flueway in it This invention is not limited to this and may apply a part of burnt-gas Q to the thing which makes a combustion chamber remain by preparing an adjustable valve gear also in an exhaust side, for example, bringing the closing stage of an exhaust valve forward. Furthermore, it is not limited to what controls self-ignition by control of residual burnt-gas Q, either, and in short, in case self-ignition combustion and jump-spark-ignition combustion are reconciled, all can be applied to the engine which is going to change a compression ratio.

[0030] Moreover, although the device in which the phase of an inhalation-of-air cam shaft and an engine's crankshaft is changed as an adjustable valve gear which changes a real compression ratio is used The angular velocity of the cam shaft to the valve gear system and crankshaft which switch two or more kinds of cams, and change a valve-lift property is changed. A valve-opening engine The valve gear system which can be changed continuously, Of course, the valve gear system which can control a closing motion stage by electromagnetic force or oil pressure freely may be used.

[0031]

[Effect of the Invention] As mentioned above, according to this invention, while being able to make combustion of both self-ignition combustion and jump-spark-ignition combustion perform good, an engine's endurance and the seal nature of combustion gas are easily securable.

[Translation done.]

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CLAIMS

[Claim(s)]
[Claim 1] In a jump-spark-ignition type internal combustion engine which makes self-ignition combustion perform by predetermined operating range, and makes jump-spark-ignition combustion perform by operating range other than said predetermined operating range An inlet valve and an exhaust valve which open and close an inhalation-of-air path and a flueway which carry out a opening to a combustion chamber synchronizing with rotation of an engine, respectively, A jump-spark-ignition type internal combustion engine which has an adjustable valve gear which changes an engine's real compression ratio by changing a closing motion stage of said inlet valve, and is characterized by changing a real compression ratio at the time of self-ignition combustion, and a real compression ratio at the time of jump-spark-ignition operation by this adjustable valve gear.
[Claim 2] A jump-spark-ignition type internal combustion engine according to claim 1 characterized by making a real compression ratio at the time of self-ignition combustion higher than a real compression ratio at the time of jump-spark-ignition operation.
[Claim 3] A jump-spark-ignition plug arranged in the center of cylinder abbreviation, and an inhalation-of-air path and a flueway which carry out a opening to a combustion chamber, An inlet valve and an exhaust valve which open and close said inhalation-of-air path and flueway synchronizing with rotation of an engine, respectively, An adjustable valve gear which changes an engine's real compression ratio by changing a closing motion stage of said inlet valve, It has a burnt-gas residual means to make a part of burnt gas remain to a combustion chamber. In a predetermined operating range Self-ignition combustion is made to perform by raising an engine's real compression ratio by said good fluctuation valve system, while making a part of burnt gas remain to a combustion chamber with said burnt-gas residual means. A jump-spark-ignition type internal combustion engine characterized by reducing an engine's real compression ratio by said good fluctuation valve system, and making jump-spark-ignition combustion by said jump-spark-ignition plug perform in operating range other than said predetermined operating range while decreasing a residual of a burnt gas by said burnt-gas residual means.
[Claim 4] Said burnt-gas residual means is a jump-spark-ignition type internal combustion engine according to claim 3 characterized by being the 2nd adjustable valve gear which makes a part of burnt gas remain to a combustion chamber by bringing forward a closing stage of said exhaust valve.
[Claim 5] The 2nd flueway in which said burnt-gas residual means was formed independently of said flueway, The 2nd exhaust valve which opens said 2nd flueway by an engine's exhaust stroke and an intake stroke, It is not concerned with rotation of an engine. A closing motion means which can open and close said 2nd flueway, since -- a jump-spark-ignition type internal combustion engine according to claim 3 characterized by introducing a burnt gas discharged by said 2nd flueway in an exhaust stroke by open Lycium chinense in said closing motion means into an intake stroke at a combustion chamber, and making a part of burnt gas remain to a combustion chamber.
[Claim 6] Said combustion chamber is a jump-spark-ignition type internal combustion engine according to claim 5 characterized by forming in an abbreviation symmetry form a side said flueway carries out [a side] a opening a side in which said inhalation-of-air path carries out a opening.

[Claim 7] Said good fluctuation valve system is a jump-spark-ignition type internal combustion engine according to claim 5 or 6 characterized by carrying out the tooth lead angle of the valve timing of said inlet valve in said predetermined operating range, raising an engine's real compression ratio, carrying out the lag of the valve timing of said inlet valve in operating range other than said predetermined operating range, and reducing an engine's real compression ratio by changing a phase of an inhalation-of-air cam shaft which drives said inlet valve, and an engine's crankshaft.
[Claim 8] A jump-spark-ignition type internal combustion engine given in either of claims 3-7 characterized by changing an actuation stage of said burnt-gas residual means, and an actuation stage of said good fluctuation valve when an engine's service condition changes between said predetermined operating range and the other operating range.
[Claim 9] When an engine's service condition changes from operating range other than said predetermined operating range to said predetermined operating range, after carrying out the tooth lead angle of the valve timing of said inlet valve, said closing motion means An aperture, A jump-spark-ignition type internal combustion engine according to claim 7 characterized by controlling said good fluctuation valve system and said closing motion means to carry out the lag of the valve timing of said inlet valve after closing said closing motion means, when an engine's service condition changes from said predetermined operating range to the other operating range.
[Claim 10] Said predetermined operating range is a jump-spark-ignition type internal combustion engine given in either of claims 1-9 characterized by being set as a partial load field.
[Claim 11] A jump-spark-ignition type internal combustion engine given in either of claims 1-10 characterized by setting a hysteresis field as the perimeter of said predetermined operating range.

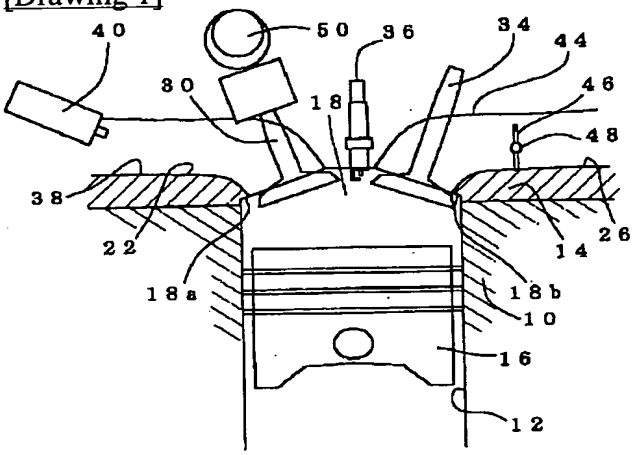
[Translation done.]

* NOTICES *

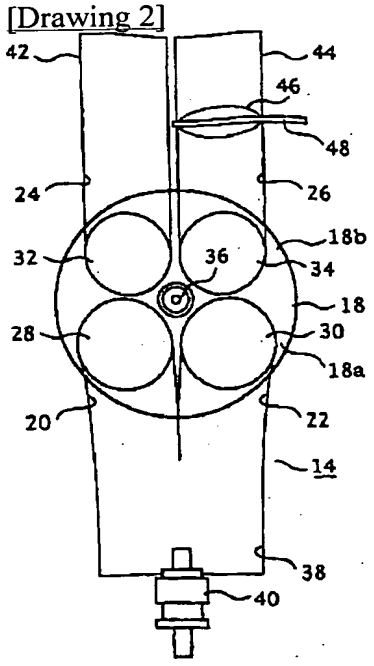
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



[Drawing 2]



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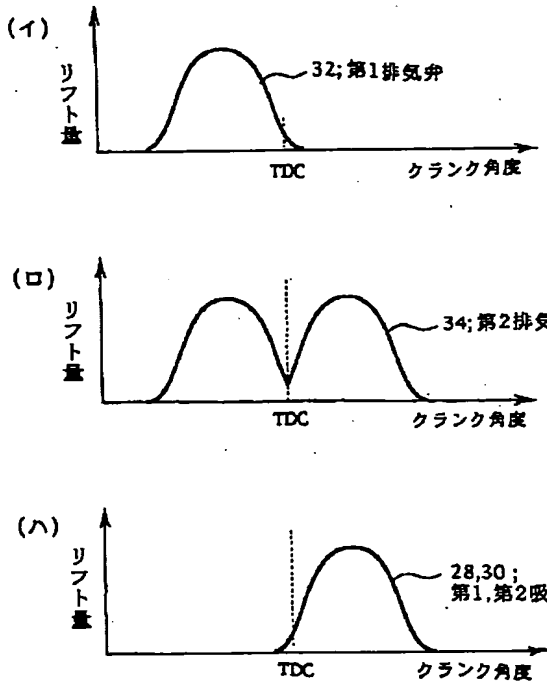

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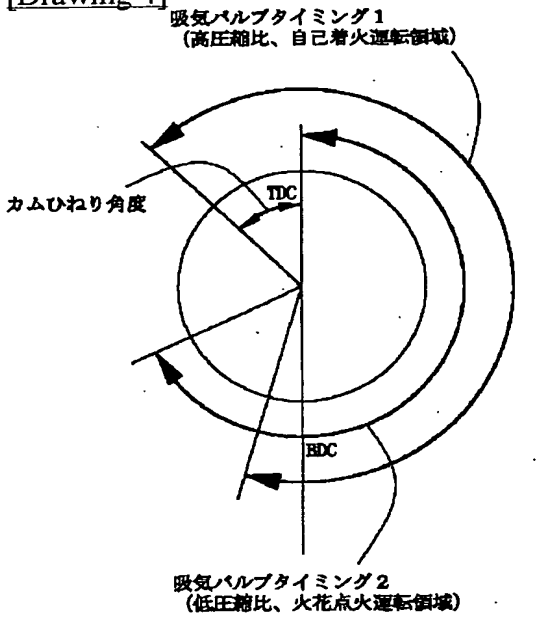
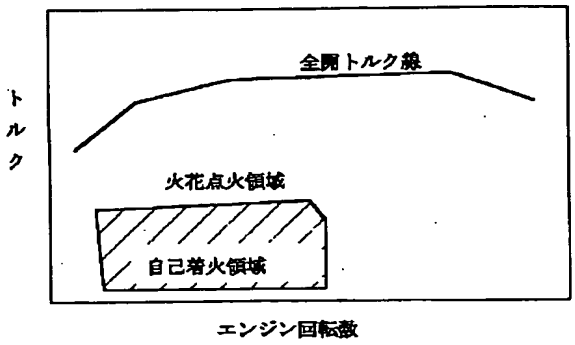


[Drawing 7]



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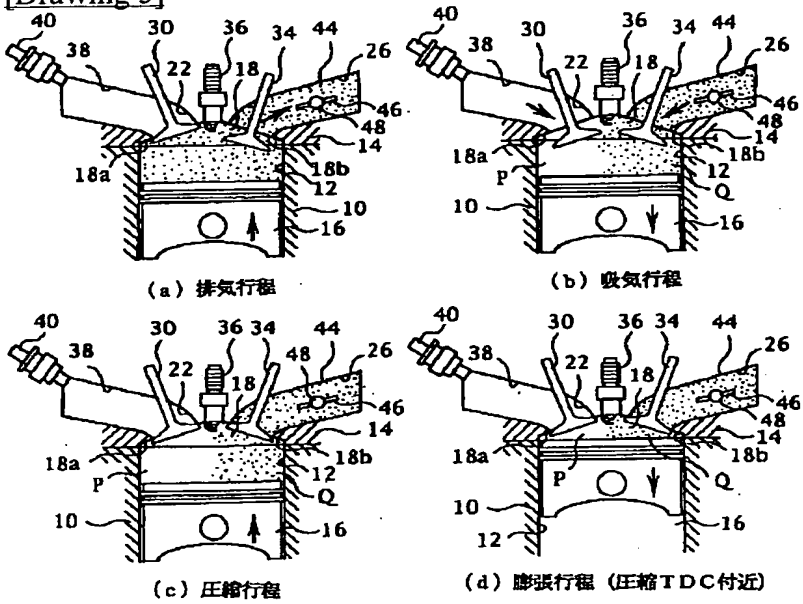

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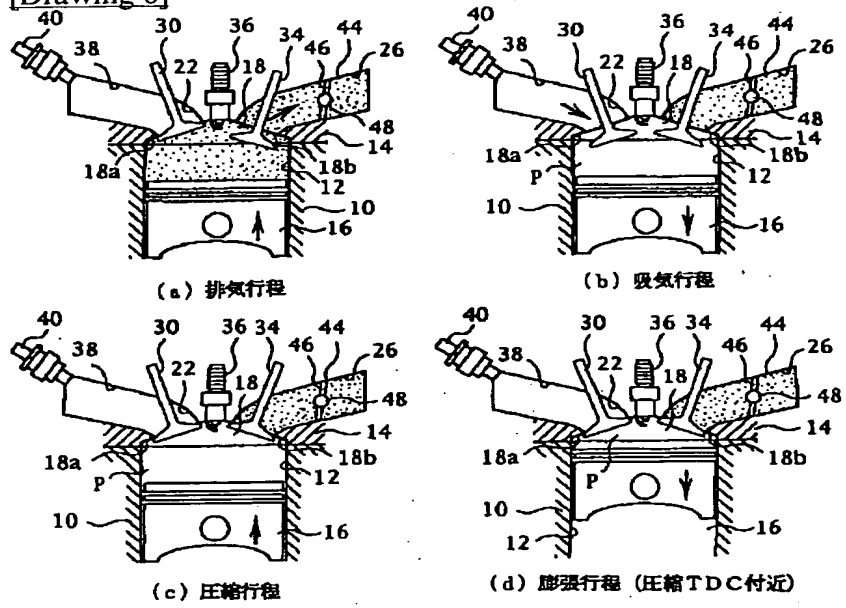

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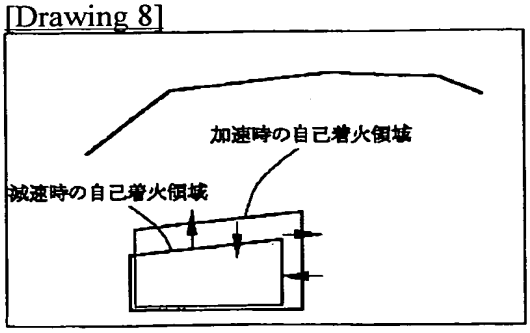

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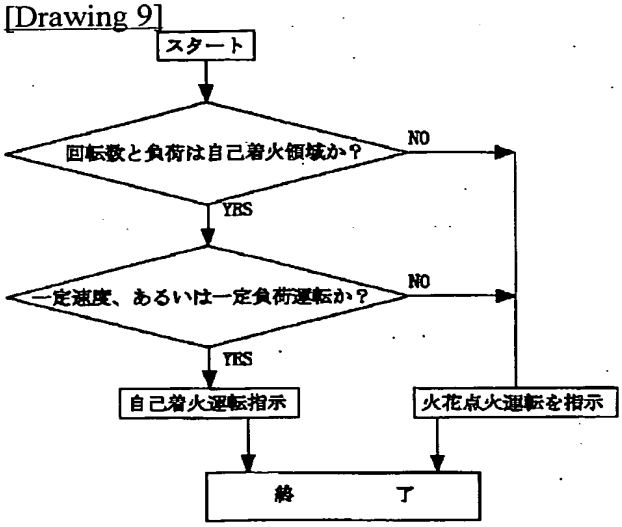

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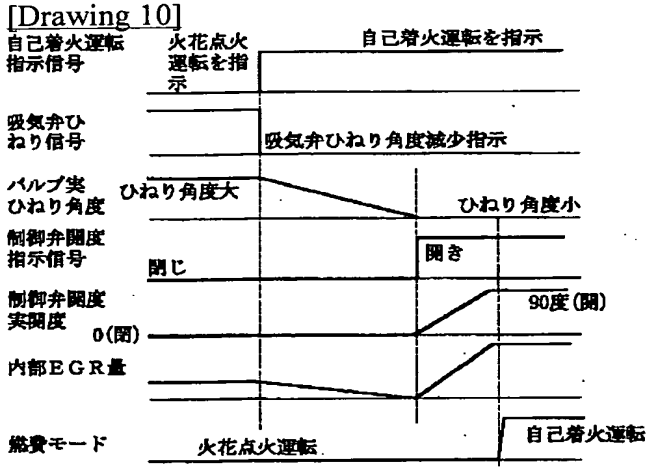

[Translation done.]